A Numerical Study on the Large Deflection Behaviour of Restrained Reinforced Concrete Beams in Fire

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Abstract

One potential way to design reinforced concrete (RC) framed structures to resist fire induced progressive collapse is to take advantage of catenary action in beams that can develop when the beams experience very large deflections. However, numerical modelling this behaviour is challenging and research studies to date on the fire resistance of RC beams have mainly focused on small deflection behaviour. This paper investigates the large deflection behaviour of restrained RC beams in fire using the ABAQUS explicit solver. This paper will demonstrate how the adopted numerical simulation method can meet the challenges of tracking the full range of restrained RC beam large deflection structural behaviour, including overcoming the problems of convergence, temporary instabilities and failure of materials. Key issues and techniques to be used in the explicit simulation method to speed up simulation process associated with the long duration of fire exposure while minimising undesirable dynamic effects due to local structural failure are discussed. The reliability of the proposed modelling method will be demonstrated through comparisons against test results of restrained RC beams at ambient temperature and in fire. Using the validated model, a numerical parametric study was carried out to investigate the influence of different axial and rotational stiffness levels at beam ends and the applied load levels on the fire response of RC beams at large deflections.

Keywords: Reinforced concrete beams, Large deflection behaviour, Catenary action, Explicit finite element method, Fire

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